Muon g-2 Update

Chris Polly

All Experimenters' Meeting

25 July 2016

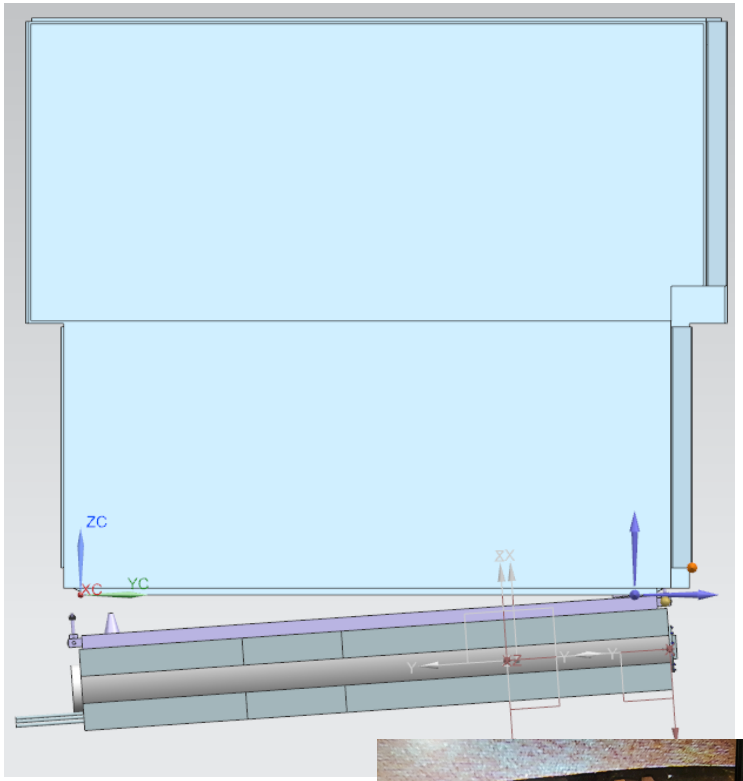
Remaining Work by CA

WBS: Control Account	BAC $M	CTG $M	% Comp
2.2: Target Station	1.8	0.7	62%
2.3: Beamlines	12.1	3.3	73%
2.4: Accel C&I	1.7	0.3	85%
3.2: Magnet	4.6	0	100%
3.3: Inflector	1.9	0.4	78%
3.4: Storage Ring Vacuum	1.3	0.7	46%
3.5: Kickers	1.6	0.4	77%
3.6: Quadrupoles	1.0	0.5	47%
3.7: Ring C&I	0.9	0	100%
3.8: Precision Field	1.5	0.4	71%
4: Detectors (DOE)	0.6	0.1	85%
5: Disassembly & Trans.	4.18	0.00	100%

- Project 80% complete overall
- $6.5M work remaining (excluding PM)
  - Half of remaining work is in beamline construction
  - Rest is distributed over many storage ring injection, storage, and field monitoring equipment
- Detector are 90% externally-funded
  - PbF2 calorimeters w/ SiPM readout (24 6x9 arrays)
  - 800 MHz waveform digitizers
  - *In vacuo* straw trackers
  - MIDAS-based DAQ
- Aiming for construction complete by end of March 2017

2.2 Target Station

- Running behind on Li lens pulsed-power supply procurements…expect to catch up.
- Bigger issue is with AP0 dump
  - Designed to pull shielding block and dump as one unit to place dump in coffin
  - Fixturing failed on one end
  - TeV dump still 400R/hr after 5 years of cool-down…13 seconds to turn screw before hitting FNAL admin limit
  - Contracted vendor to drill through 13' steel shielding block to attach dump
  - Additional design work to prevent future failure and cost to replace shielding module



Beam Left – 20 R/hr

US
427 R/hr

DS
355 R/hr

Beam Right – 25 R/hr

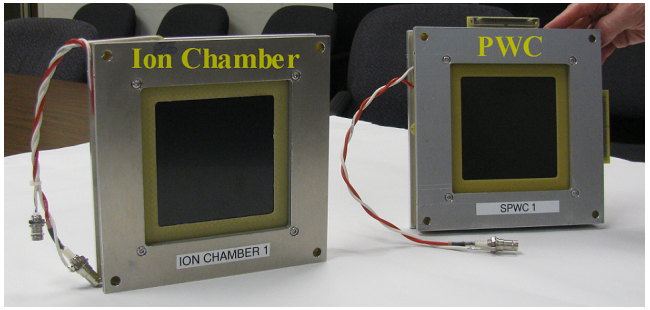
2.3 Beamlines

- M1 final focus onto AP0 target complete
- M2/M3 lines essentially complete
  - Includes new high density FODO to increase muon capture efficiency
- Bulk of remaining work is in the Delivery Ring injection and extraction, D30 straight section, and final M4/M5 beamline to bring muons to g-2 ring
- Magnet production within TD
  - C-magnet and Lambertson complete
  - EDWA and 4 MDCE dipoles to be delivered

C-magnet at test facility

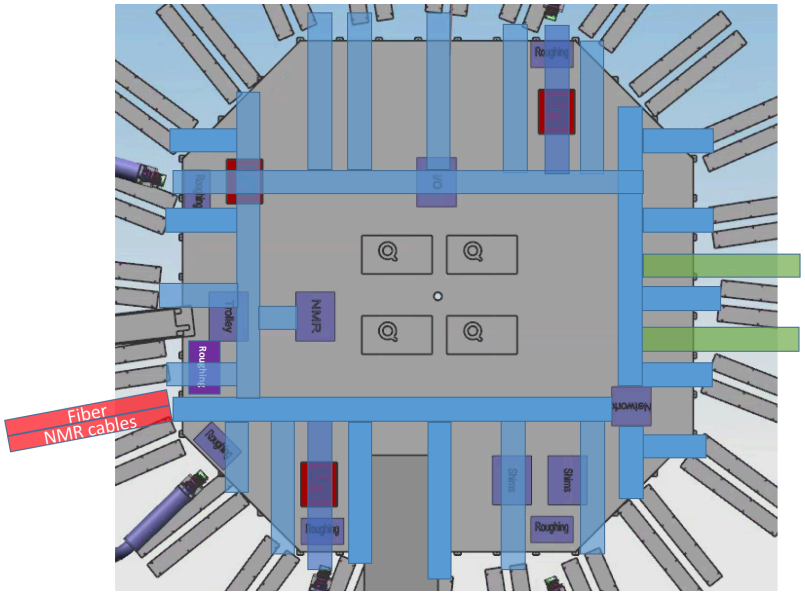
2.4 Accelerator C&I

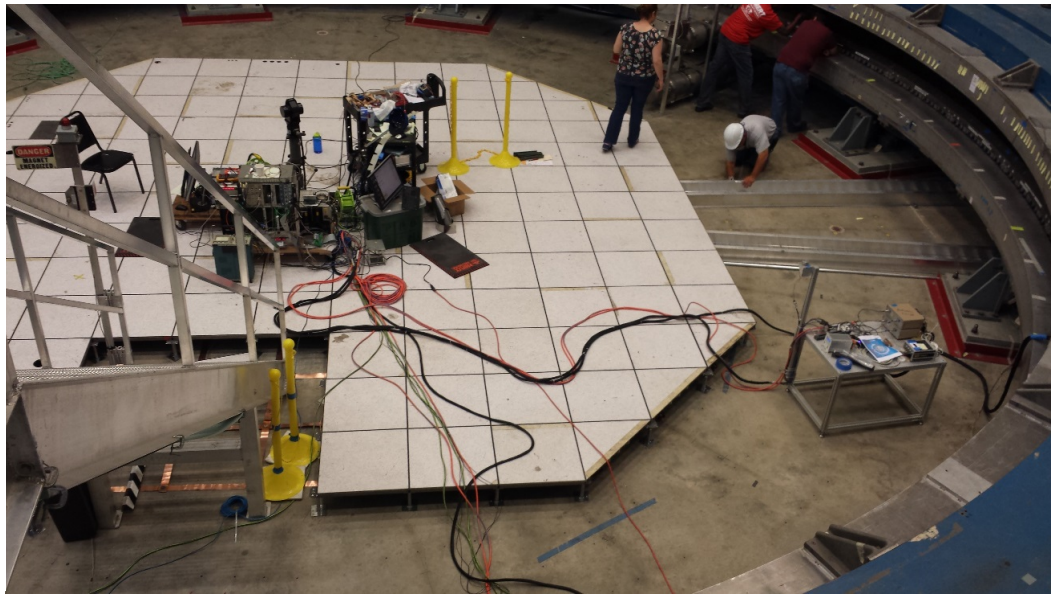
- Had quite a few problems with anti-vacuum chambers that allow Ion Chambers and PWC to be retracted from muon…now resolved
- SEMs mostly installed
- Controls infrastructure complete and safety systems 90% installed



3.2 Ring

- Ring CA is 100% complete
- Installing infrastructure in ring center
  - False floor and grounding distribution installed
  - Electrical distribution in progress
- Planning on warming ring up in Oct/Nov for 2-3 months to repair internal He leak
- Will be completing a number of other improvements during warm up
  - Rough-in connections for g-2/Mu2e permanent purifier
  - Moving a N2 line in cryo plant to accommodate Mu2e
  - Additional vacuum ports for g-2 cryostats
  - Replace large N2 tank supply valve, install pneumatic control of g-2 ring N2, inspect TeV era valves for particular failure mode

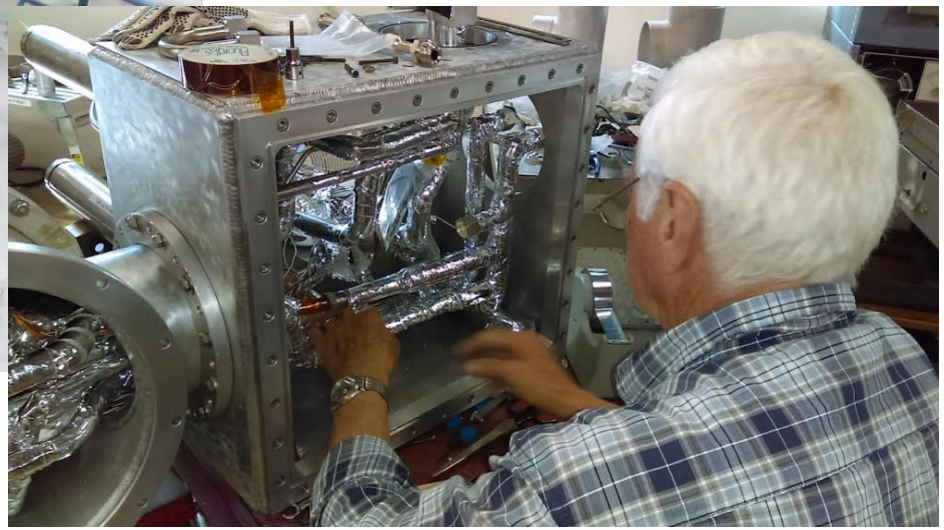




3.3 Inflector

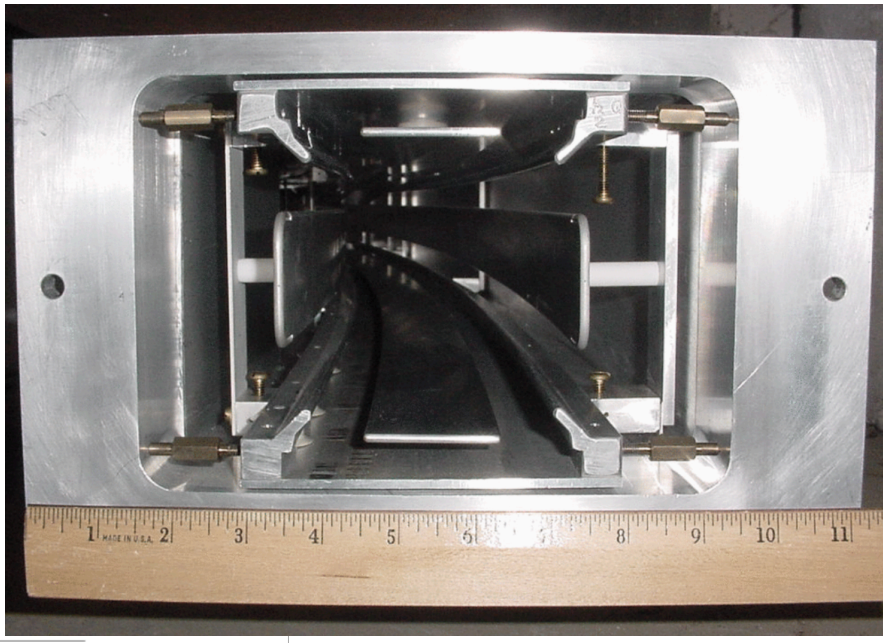
- All old inflector equipment ready to install in MC-1
  - Inflector cold mass in its vacuum chamber
  - Valve box rebuilt
  - Lead can refurbished, Indium joints redone
  - New power supply installed tested for AC field perturbations
- Aiming to be cold, fully-powered, and tested in 1.5T storage ring field by October

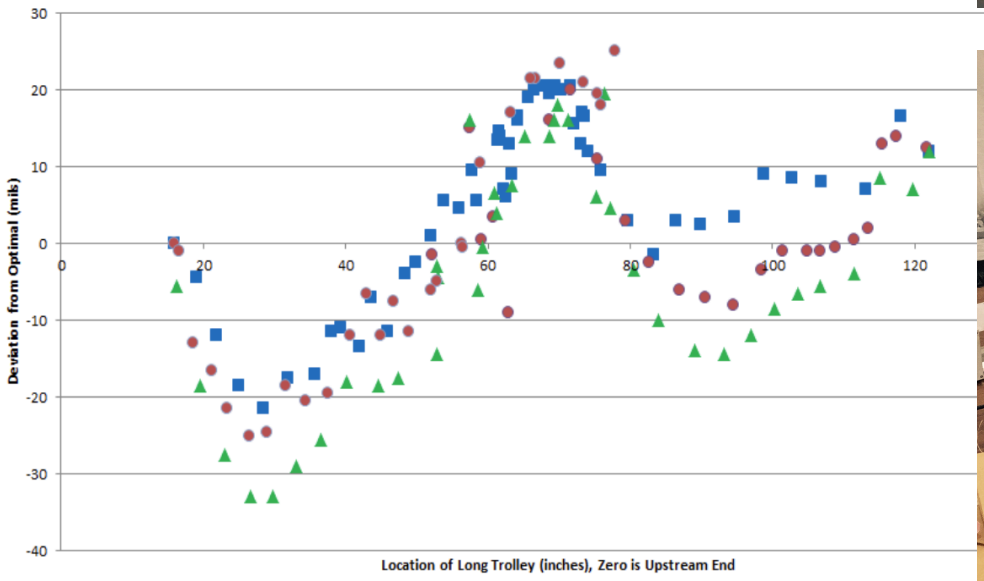

MS Series IV 30 kW, 45 kW, and 60 kW Models

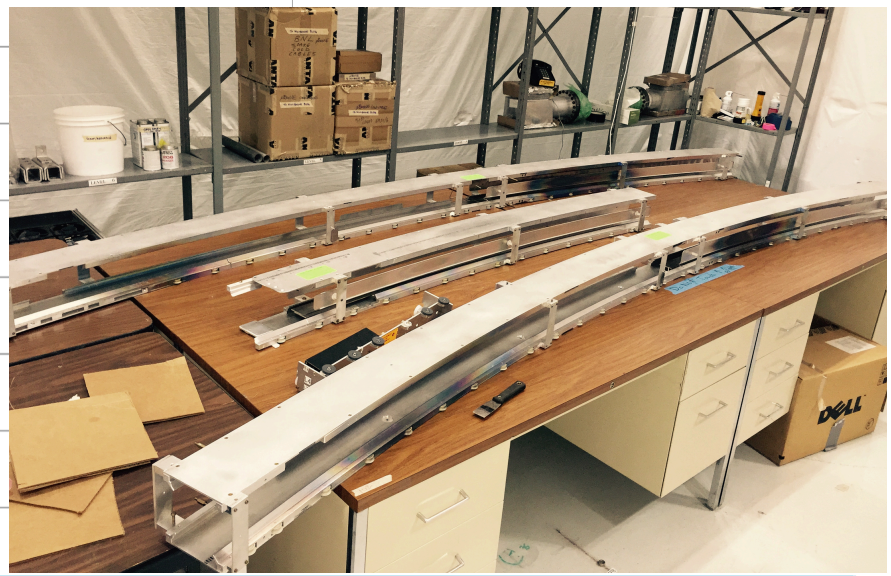


3.4 Storage Ring Vacuum

- Currently critical path for project
  - Had difficulty in meeting alignment specs for internal trolley rails and quad plates, e.g. +/-0.5mm tolerances when vacuum deforms by 0.5-1.0mm
  - Procedures now worked out
  - 7/12 chambers ready to install
- All turbo pumps now received, manifolds under construction
- Aiming to start installation in August and finish by end of September

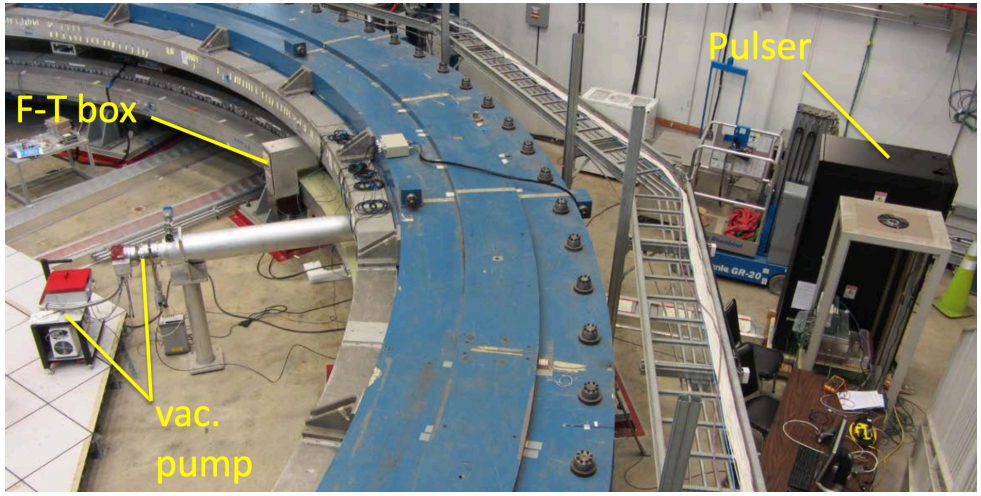


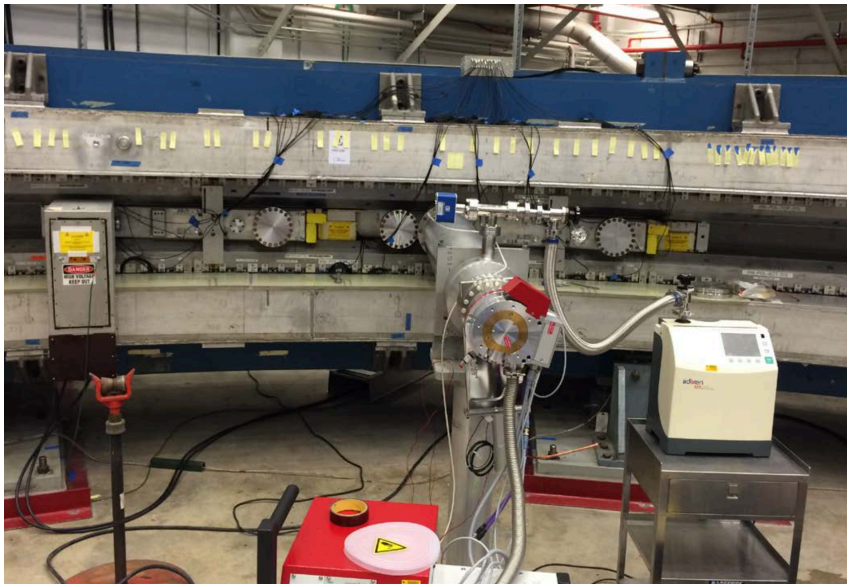




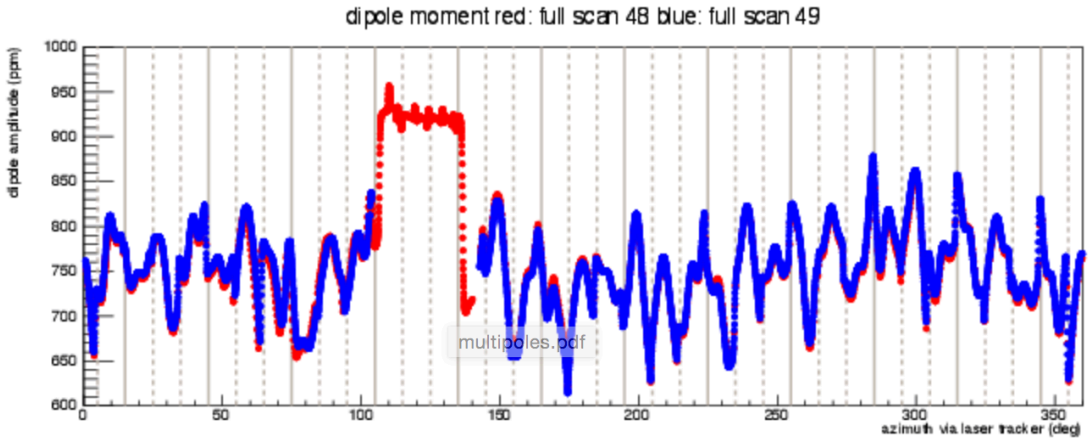
3.6 Quadrupoles

- Received the first +32kV solid state pulse from Applied Pulsed power
- Very successful test week in June with quad chamber temporarily installed
  - Operated pulser at Fermilab at full voltage and rep rate
  - Showed for first time that the quads can achieve full 32kV operating voltage in 1.5T field
  - Verified spark monitoring scheme and pickup instrumentation works well
  - Also first test of feed-throughs in fringe field
- Caveats
  - Were not able to test negative voltage unit planning on completing that test later this week
  - Spark rate is 20x too high…need to determine if we have an issue with a component or simply need more conditioning

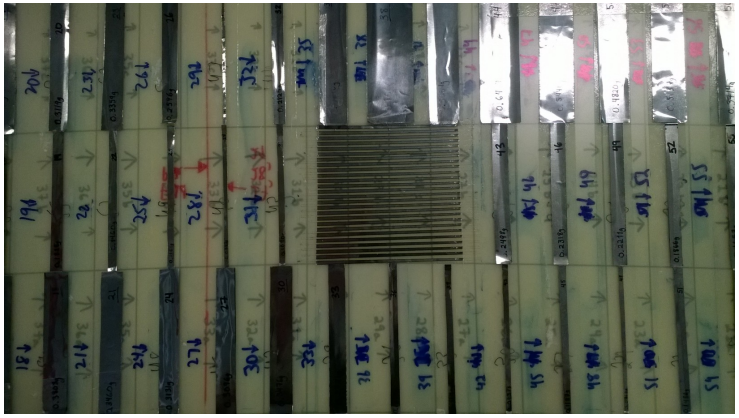


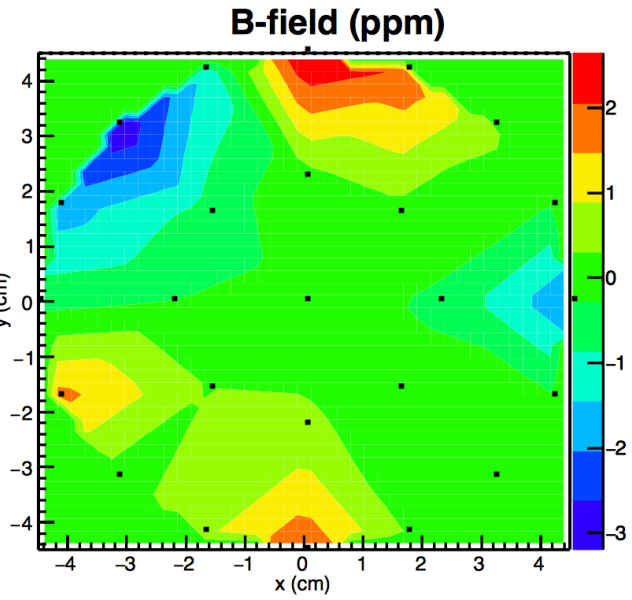


Field work

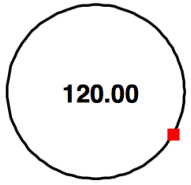


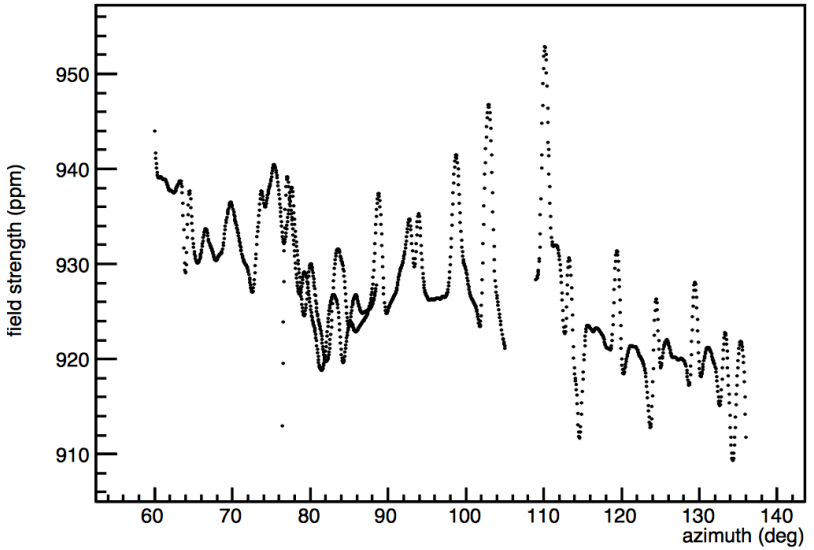
- Iron laminations working extremely well!





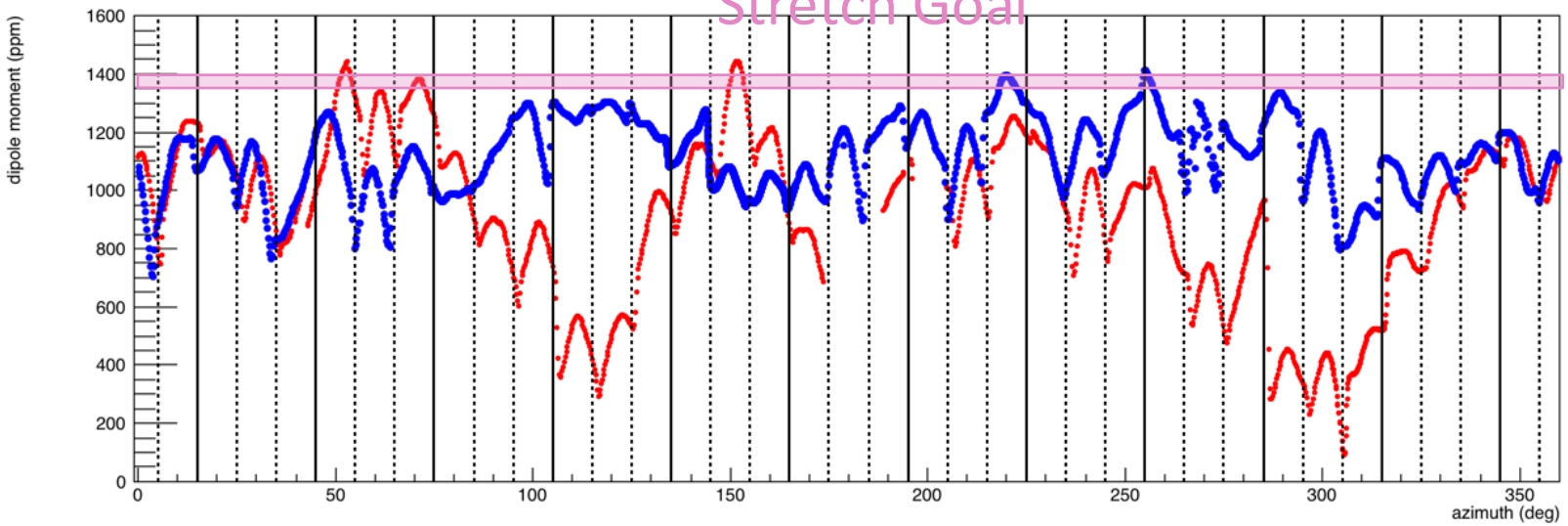
	Norm	Skew
Quad	0.20	-0.35
Sext	-1.11	1.12
Octu	-0.85	-0.72
Decu	0.63	-0.05
Dipole	-0.0	





Status through Mid Feb

Oct 14-2015 → Feb 15, 2016



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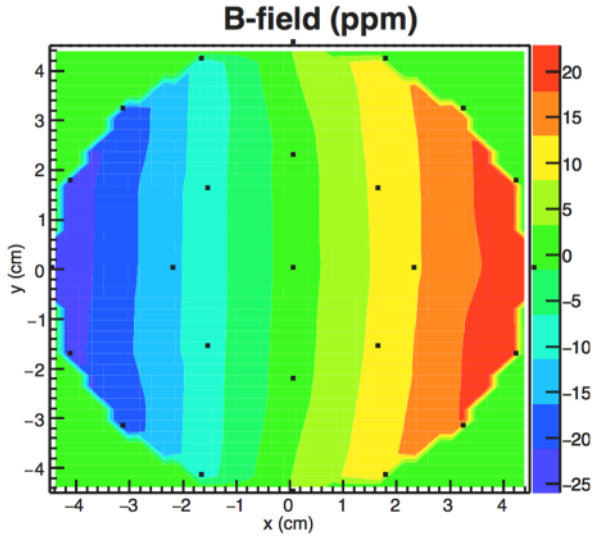
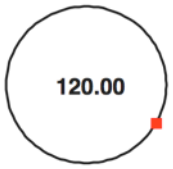
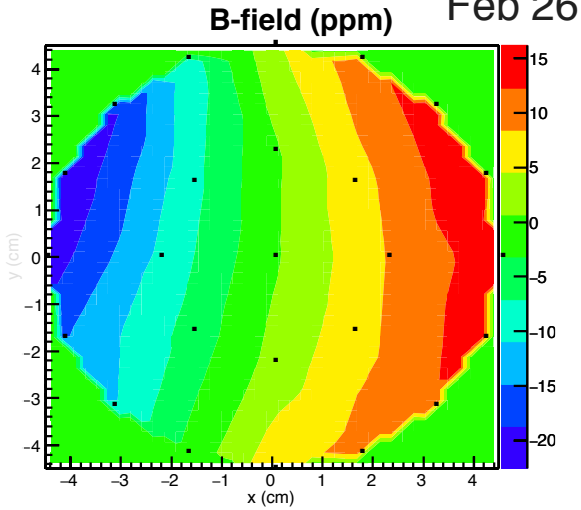


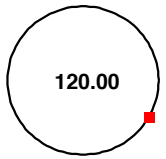
	Norm	Skew
Quad	25.13	-0.53
Sext	-1.99	-0.11
Octu	-1.16	-0.31
Decu	0.95	-0.07
Dipole	0.0	



Feb 26, 2016



	Norm	Skew
Quad	19.09	-1.93
Sext	-3.55	2.82
Octu	-1.07	-0.47
Decu	1.06	0.10
Dipole	0.0	



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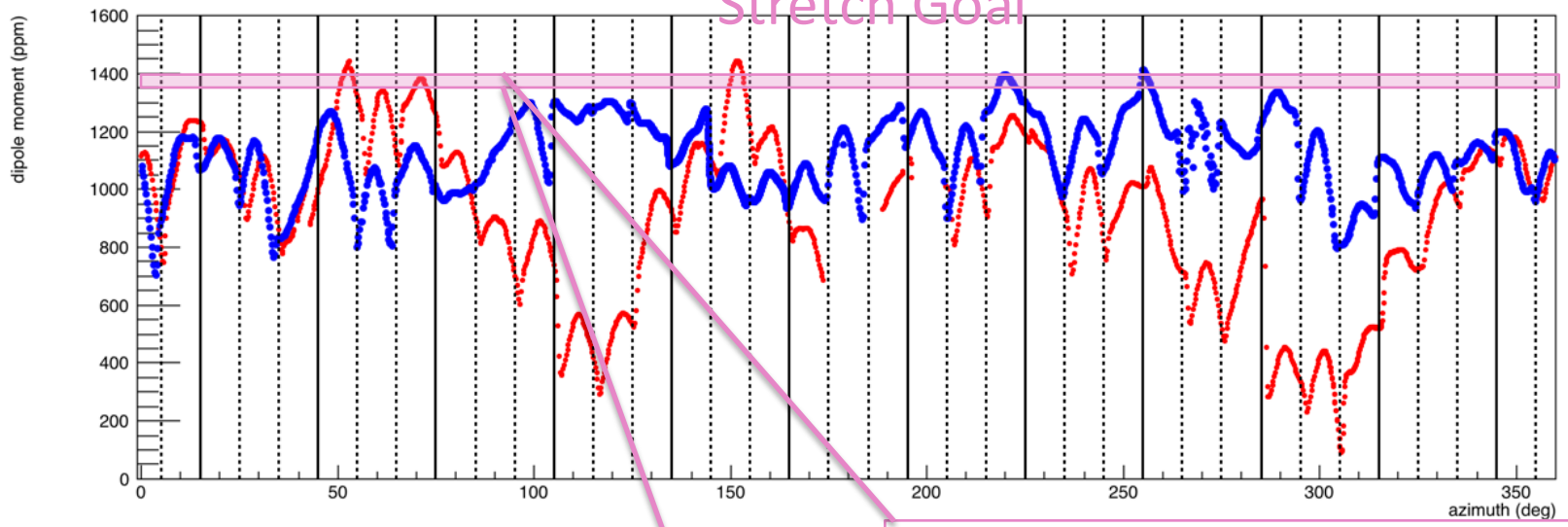

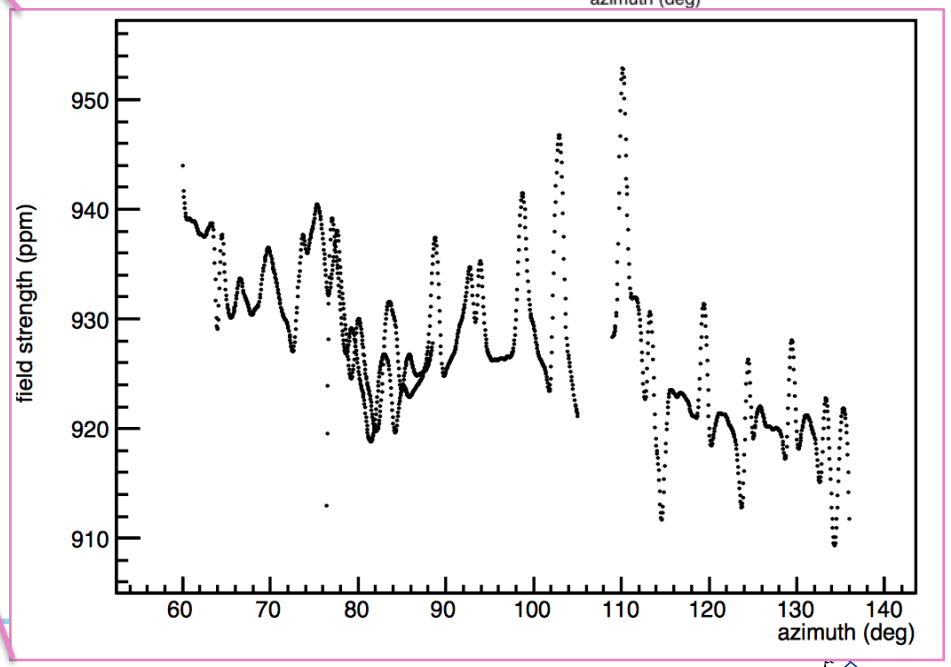

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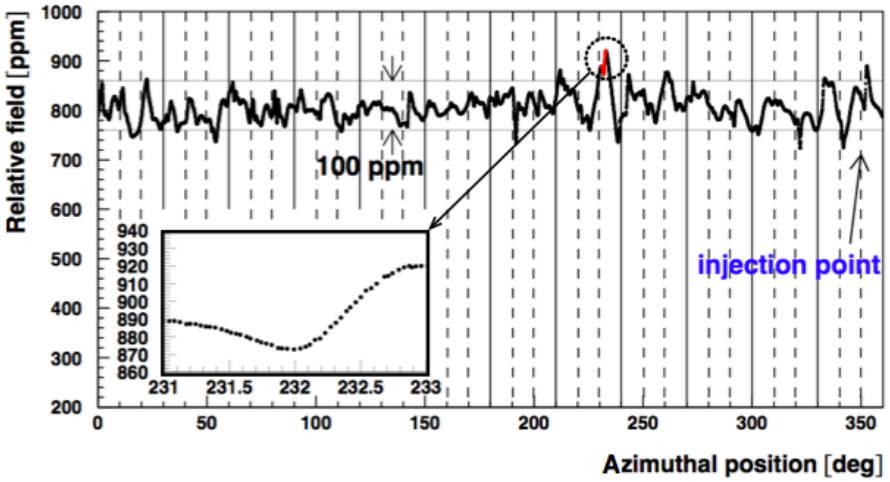
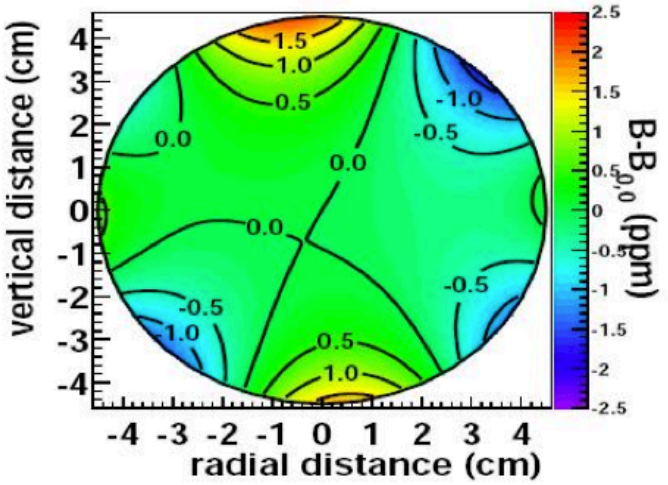
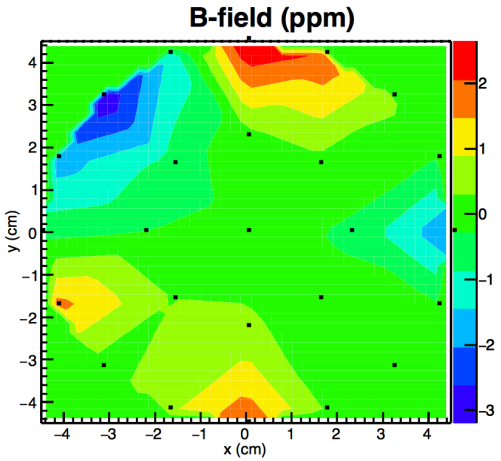




BNL Final Field



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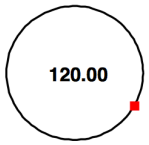
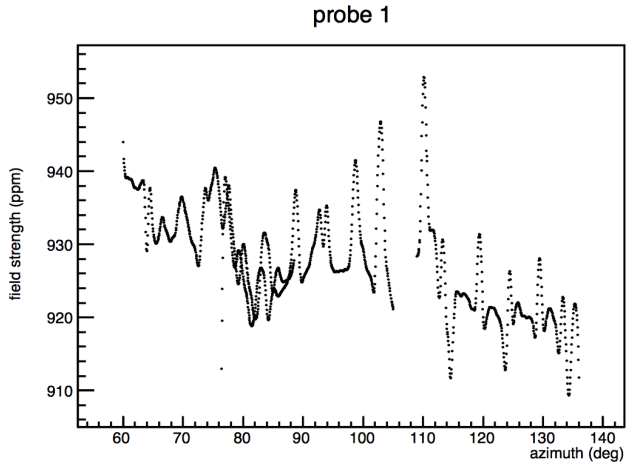
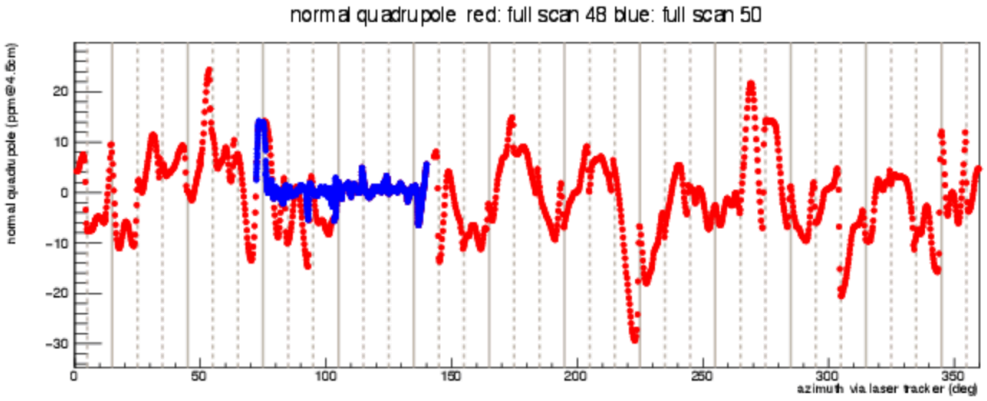


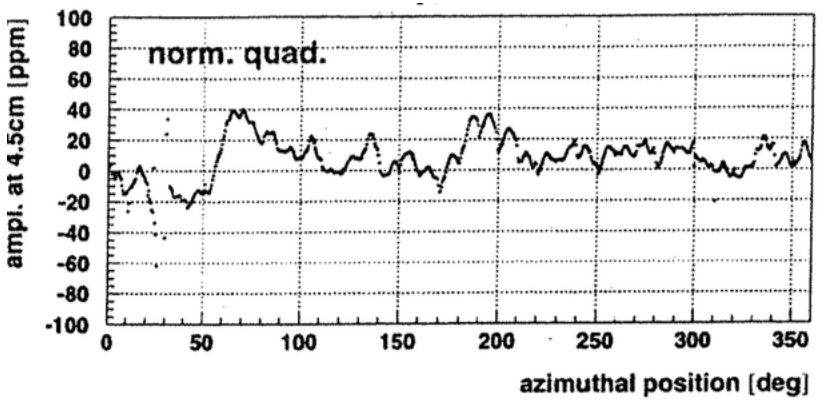


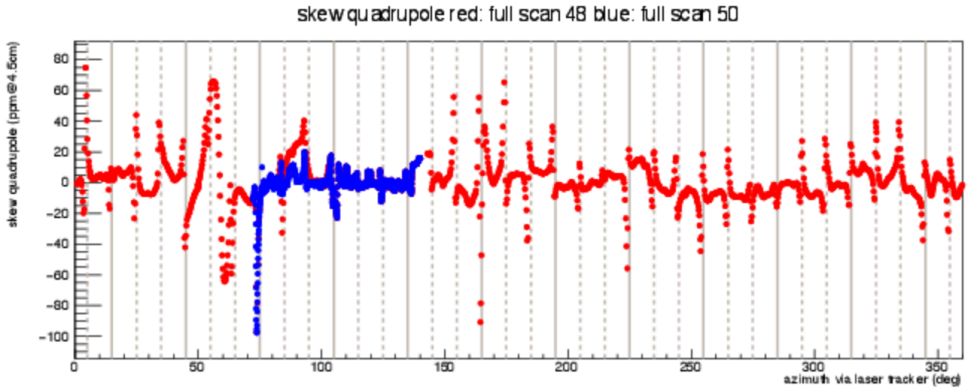
FNAL 60° lamination test

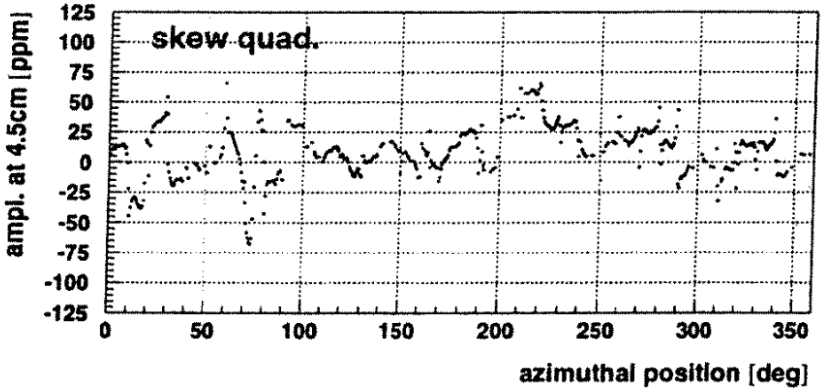
2d contour plot after laminations is already as good as BNL final field. Still have active coils with 100 current loops that are used as final tuning knob

Field work – higher moments









- Azimuthal variations 10x better
- The field team might have just lowered the systematic floor of the experiment

Conclusions

- Work is progressing well
- Project remains healthy with 54% contingency on work remaining, although burn rate in June/July was not great
- Anticipate being done with construction in March 2017
- Commissioning plan
  - ARR in April
  - Start tuning beam through beamlines with goal of getting some beam to g-2 by FY17 shutdown
  - Will likely have to wait until after FY17 shutdown to get clean muon beam (protons removed) with substantial intensity